SECTION 1

GENERAL INFORMATION

1.1 PURPOSE

This specification provides guidelines for the development of environmental verification requirements for GSFC payloads, subsystems and components and describes methods for implementing those requirements. It contains a baseline for demonstrating by test or analysis the satisfactory performance of hardware in the expected mission environments, and that minimum workmanship standards have been met.

It presents the GSFC project and its contractors with source material and a model for preparing a project verification plan and a verification specification. It is not intended to be used in toto for contractual direction; rather the GSFC project verification management must select from the options to fulfill the specific payload (spacecraft) requirements in accordance with the launch vehicle to be used, Space Transportation System (STS), Atlas, Delta, Pegasus, Scout, Titan, etc., or to cover other mission-specific considerations. Most of the verification program is generally the same for STS and the expendable launch vehicles (ELV) payloads (spacecraft); the differences are noted in the text and the tables.

It is consistent with established GSFC payload assurance requirements. It elaborates on those requirements, gives guideline test levels, provides guidance in the choice of test options, and describes acceptable test and analytical methods for implementing the requirements.

1.2 APPLICABILITY AND LIMITATIONS

The specification applies to GSFC hardware that is to be launched on either the STS or on an ELV. The verification policy is defined by Goddard Management Instruction (GMI) 5330.7. Hardware launched by balloons and sounding rockets is not included. In accordance with the GMI, the specification applies to the following:

a. All space flight hardware, including interface hardware, that is developed as part of a payload managed by GSFC, whether developed by (1) GSFC or any of its contractors, (2) another NASA center, or (3) an independent agency; and

b. All space flight hardware, including interface hardware, that is developed by GSFC or any of its contractors and that is provided to another NASA installation or independent agency as part of a payload that is not managed by GSFC.

The requirements of this specification are intended for high-reliability, Class B, payloads. However, the specification shall also serve as a model in form and provide source material for deriving either less stringent verification requirements and specifications for higher-risk, lower-cost payloads, Class C or D, or for more stringent requirements and specifications for Class A payloads.

The provisions herein are generally limited to the verification of STS or ELV payloads and to those activities (with emphasis on the environmental verification program) that are closely associated with such verification, such as workmanship and functional testing. If the payload is to be serviced or recovered by the STS, then all STS verification and safety requirements apply..

The specification is written in accordance with the current GSFC practice of using a single protoflight payload for both qualification testing and space flight (see definition of hardware, 1.8). The protoflight verification program, therefore, is given as the nominal test program.

1.3 THE GSFC VERIFICATION APPROACH

Goddard Space Flight Center endorses the full systems verification approach in which the entire payload is tested or verified under conditions that simulate the flight operations and flight environment as realistically as possible. The specification is written in accordance with that view. However, it is recognized that there may be unavoidable exceptions, or conditions which make it preferable to perform the verification activities at lower levels of assembly. For example, testing at lower levels of assembly may be necessary to produce sufficient environmentally induced stresses to uncover design and workmanship flaws. These test requirements should be tailored for each specific space program. For some projects, tailoring might relax the requirements in this standard; however, for other projects the requirements may be made more stringent to demonstrate more robustness or greater confidence in the system performance.

Since testing at the component (or unit) level, or lower level of assembly for large components, often becomes a primary part of the verification program, all components should be operating and monitored during all environmental tests if practicable.

Environmental verification of hardware is only a portion of the total assurance effort at GSFC that establishes confidence that a payload will function correctly and fly a successful mission. The environmental test program provides confidence that the design will perform when subjected to environments more severe than expected during the mission, and provides environmental stress screening to uncover workmanship defects.

The total verification process also includes the development of models representing the hardware, tests to verify the adequacy of the models, analyses, alignments, calibrations, functional/performance tests to verify proper operation, and finally end-to-end tests and simulations to show that the total system will perform as specified.

Other tests not included herein may be performed as required by the project. The level, procedure, and decision criteria for performing any such additional tests shall be included in the system verification plan and system verification specification (section 2.1).

1.4 OTHER ASSURANCE REQUIREMENTS

In addition to the verification program, the assurance effort include parts and materials selection and control, reliability assessment, quality assurance, software assurance, design reviews, and system safety.

1.5 RESPONSIBILITY FOR ADMINISTRATION

The responsibility and authority for decisions in applying the requirements of this specification rest with the project manager. The general/environmental requirements are intended for use by the flight project managers, assisted by the flight assurance managers, and verification managers in developing project-unique performance verification requirements, plans, and specifications that are consistent with current NASA program/project planning.

The requirements thus derived and the deviations from the requirements of this document are subject to review by the Director of Flight Assurance, GSFC.

1.6 DISTRIBUTION OF REVISIONS

Users who receive this document in the original distribution will also receive revisions and changes. Others can request changes from the Assurance Requirements Office Information Center, Code 300.1, NASA/GSFC, Greenbelt, Maryland, 2077l. Users are advised to contact the AROIC to make sure they have the latest revision.

1.7 APPLICABLE DOCUMENTS

The following documents may be needed in formulating the environmental test program. The user must ensure that the latest versions are procured and that the most recent changes and additions are included.

1.7.1 Safety Requirements - NSTS 1700.7, Safety Policy and Requirements for Payloads using the NSTS, states that "the safety of any hazardous payload safety-critical equipment shall be satisfactorily verified." Because testing is one of the acceptable methods for verifying safety compliance, the environmental test program may be influenced by safety considerations.

1.7.2 NSTS Interface Requirements - Portions of ICD 2-19001, Shuttle Orbiter/Cargo Standard Interfaces (Attachment 1 to NSTS 07700, Vol. XIV) have been incorporated herein primarily to make up part of the electromagnetic compatibility (EMC) provisions. ICD 2-19001 should also be consulted as indicated for implementing some of the other sections. Similarly, many of the provisions of NSTS 14046, Payload Interface Verification Requirements have been incorporated in this specification. STS users should, however, refer to that document to ensure full compliance.

1.7.3 ELV Payload User Manuals - The most recent versions of the following documents are applicable in accordance with the launch vehicle to be used by the project.

1.7.3.1 Ariane 4 User's Manual, Arianespace Inc., U.S. subsidiary, 700 13th St. N.W., Suite 230, Washington D.C. 20005.

1.7.3.2 Ariane 5 User's Manual, Arianespace Inc., U.S. subsidiary, 700 13th St. N.W., Suite 230, Washington D.C. 20005.

1.7.3.3 Atlas Mission Planner's Guide for the Atlas Launch Vehicle Family, Lockheed Martin Astronautics Commercial Launch Services, Inc., 5001 Kearny Villa Road, San Diego, California 92123.

1.7.3.4 Conestoga Payload User's Guide, EER Systems Corp., 1593 Spring Hill Road, Vienna, VA 22182

1.7.3.5 Delta II Payload Planner's Guide (MDC H 3224C), McDonnell Douglas Aerospace, 5301 Bolsa Ave., Huntington Beach, California 92647

1.7.3.6 Lockheed Martin Launch Vehicle User’s Guide, Preliminary Release, Lockheed Martin Astronautics, P.O. Box 179, Denver, Colorado 80201.

1.7.3.7 Commercial Pegasus Launch System-Payload User's Guide, Orbital Sciences Corporation, 21700 Atlantic Blvd., Dulles, VA. 20116.

1.7.3.8 Scout User's Manual, LTV Aerospace and Defense, Vought Missiles and Advanced Programs Division, P.O. Box 650003, Dallas, Texas 75265-0003.

1.7.3.9 Commercial Taurus Launch System-Payload User's Guide, Orbital Sciences Corporation, 21700 Atlantic Blvd., Dulles, VA. 20116.

1.7.3.10 Titan II Space Launch Vehicle: Payload User's Guide, Lockheed Martin Astronautics, P.O. Box 179, Denver, Colorado 80201.

1.7.3.11 Titan III Commercial Launch Services Customer Handbook, Lockheed Martin Astronautics, P.O. Box 179, Denver, Colorado 80201.

1.7.3.12 Titan IV User's Handbook (MCR-86-2541), Lockheed Martin Astronautics, P.O. Box 179, Denver, Colorado 80201.

1.7.4 Fracture Control and Stress Corrosion - NSTS 1700.7, above, states the policy on fracture control for the STS. MSFC-SPEC-522, Stress Corrosion Requirements, provides design criteria for preventing stress corrosion. Implementation of fracture control and stress corrosion prevention measures on GSFC projects shall be in accordance with GSFC document 731-0005-83, latest revision, Fracture Control Plan for Payloads Using the Space Transportation System, or Fracture Control Plan for Payloads Using Expendable Launch Vehicles.

1.7.5 Spacecraft Tracking and Data Network Simulation - STDN No. 101.6, Portable Simulation System and Simulations Operation Center Guide for TDRSS & GSTDN, describes the Spacecraft Tracking and Data Network (STDN) and the Tracking and Data Relay Satellite (TDRS)/Ground STDN network simulation programs, and the Simulations Operations Center (SOC). It also discusses end-to-end simulation techniques. STDN No. 408, TDRS and GSTDN Compatibility Test Van Functional Description and Capabilities, describes the equipment and the compatibility test system.

1.7.6 Deep Space Network (DSN) Simulation - The Deep Space Network/Flight Project Interface Design Handbook, 8l0-5, Jet Propulsion Laboratory, California Institute of Technology, Vol. I, Module TSS-10, describes existing payload (spacecraft) telemetry and command simulation capability. Vol. II describes proposed DSN capability.

1.7.7 Payload Bay Acoustic Study - The PACES computer program for making estimates of the effects of a payload on the acoustic environment of the payload bay is contained in NASA CR 159956, Space Shuttle Payload Bay Acoustic Protection Study, Vols. I through V.

l.7.8 Military Standards for EMC Testing - Pertinent sections of the following standards are needed to conduct the EMC tests:

a. MIL-STD-461C, Electromagnetic Interference Characteristics Requirements for Equipment.

b. MIL-STD-462, Electromagnetic Interference Characteristics, Measurement of, as amended by Notice l.

c. MIL-STD-463A, Definitions and Systems of Units, Electromagnetic Interference and Electromagnetic Compatibility Technology.

1.7.9 Military Standards for Non-Destructive Evaluation

a. MIL-I-6870E, Inspection Program Requirements, Non-Destructive Testing for Aircraft and Missile Materials and Parts.

b. MIL-STD-410D, Non-Destructive Testing, Personnel Qualification and Certification (Eddy Current, Liquid Penetrant, Magnetic Particle, Radiographic and Ultrasonic).

1.8 DEFINITIONS

The following definitions apply within the context of this specification:

Acceptance Tests: The verification process that demonstrates that hardware is acceptable for flight. It also serves as a quality control screen to detect deficiencies and, normally, to provide the basis for delivery of an item under terms of a contract.

Assembly: See Level of Assembly.

Component: See Level of Assembly.

Configuration: The functional and physical characteristics of the payload and all its integral parts, assemblies and systems that are capable of fulfilling the fit, form and functional requirements defined by performance specifications and engineering drawings.

Contamination: The presence of materials of molecular or particulate nature which degrade the performance of hardware.

Design Qualification Tests: Tests intended to demonstrate that the test item will function within performance specifications under simulated conditions more severe than those expected from ground handling, launch, and orbital operations. Their purpose is to uncover deficiencies in design and method of manufacture. They are not intended to exceed design safety margins or to introduce unrealistic modes of failure. The design qualification tests may be to either “prototype” or “protoflight” test levels.

Design Specification: Generic designation for a specification that describes functional and physical requirements for an article, usually at the component level or higher levels of assembly. In its initial form, the design specification is a statement of functional requirements with only general coverage of physical and test requirements. The design specification evolves through the project life cycle to reflect progressive refinements in performance, design, configuration, and test requirements. In many projects the end-item specifications serve all the purposes of design specifications for the contract end-items. Design specifications provide the basis for technical and engineering management control.

Electromagnetic Compatibility (EMC): The condition that prevails when various electronic devices are performing their functions according to design in a common electromagnetic environment.

Electromagnetic Interference (EMI): Electromagnetic energy which interrupts, obstructs, or otherwise degrades or limits the effective performance of electrical equipment.

Electromagnetic Susceptibility: Undesired response by a component, subsystem, or system to conducted or radiated electromagnetic emissions.

End-to-End Tests: Tests performed on the integrated ground and flight system, including all elements of the payload, its control, stimulation, communications, and data processing to demonstrate that the entire system is operating in a manner to fulfill all mission requirements and objectives.

Failure: A departure from specification that is discovered in the functioning or operation of the hardware or software. See nonconformance.

Flight Acceptance: See Acceptance Tests.

Fracture Control Program: A systematic project activity to ensure that a payload intended for flight has sufficient structural integrity as to present no critical or catastrophic hazard. Also to ensure quality of performance in the structural area for any payload (spacecraft) project. Central to the program is fracture control analysis, which includes the concepts of fail-safe and safe-life, defined as follows:

a. Fail-safe: Ensures that a structural element, because of structural redundancy, will not cause collapse of the remaining structure or have any detrimental effects on mission performance.

b. Safe-life: Ensures that the largest flaw that could remain undetected after non-destructive examination would not grow to failure during the mission.

Functional Tests: The operation of a unit in accordance with a defined operational procedure to determine whether performance is within the specified requirements.
Hardware: As used in this document, there are two major categories of hardware as follows:

a. Prototype Hardware: Hardware of a new design; it is subject to a design qualification test program; it is not intended for flight.

b. Flight Hardware: Hardware to be used operationally in space. It includes the following subsets:

   (1) Protoflight Hardware: Flight hardware of a new design; it is subject to a qualification test program that combines elements of prototype and flight acceptance verification; that is, the application of design qualification test levels and flight acceptance test durations.

   (2) Follow-On Hardware: Flight hardware built in accordance with a design that has been qualified either as prototype or as protoflight hardware; follow-on hardware is subject to a flight acceptance test program.

   (3) Spare Hardware: Hardware the design of which has been proven in a design qualification test program; it is subject to a flight acceptance test program and is used to replace flight hardware that is no longer acceptable for flight.

   (4) Reflight Hardware: Flight hardware that has been used operationally in space and is to be reused in the same way; the verification program to which it is subject depends on its past performance, current status, and the upcoming mission.

Level of Assembly: The environmental test requirements of GEVS generally start at the component or unit level assembly and continue hardware/software build through the system level (referred to in GEVS as the payload or spacecraft level). The assurance program includes the part level. Verification testing may also include testing at the assembly and subassembly levels of assembly; for test recordkeeping these levels are combined into a "subassembly" level. The verification program continues through launch, and on-orbit performance. The following levels of assembly are used for describing test and analysis configurations:

Assembly: A functional subdivision of a component consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole. Examples are a power amplifier and gyroscope.

Component: A functional subdivision of a subsystem and generally a self-contained combination of items performing a function necessary for the subsystem's operation. Examples are electronic box, transmitter, gyro package, actuator, motor, battery. For the purposes of this document, "component" and "unit" are used interchangeably.

Instrument: A spacecraft subsystem consisting of sensors and associated hardware for making measurements or observations in space. For the purposes of this document, an instrument is considered a subsystem (of the spacecraft).

Module: A major subdivision of the payload that is viewed as a physical and functional entity for the purposes of analysis, manufacturing, testing, and recordkeeping. Examples include spacecraft bus, science payload, and upper stage vehicle.

Part: A hardware element that is not normally subject to further subdivision or disassembly without destruction of design use. Examples include resistor, integrated circuit, relay, connector, bolt, and gaskets.

Payload: An integrated assemblage of modules, subsystems, etc., designed to perform a specified mission in space. For the purposes of this document, "payload" and "spacecraft" are used interchangeably. Other terms used to designate this level of assembly are Laboratory, Observatory, and satellite.

Spacecraft: See Payload. Other terms used to designate this level of assembly are Laboratory, Observatory, and satellite.

Section: A structurally integrated set of components and integrating hardware that form a subdivision of a subsystem, module, etc. A section forms a testable level of assembly, such as components/units mounted into a structural mounting tray or panel-like assembly, or components that are stacked.

Subassembly: A subdivision of an assembly. Examples are wire harness and loaded printed circuit boards.

Subsystem: A functional subdivision of a payload consisting of two or more components. Examples are structural, attitude control, electrical power, and communication subsystems. Also included as subsystems of the payload are the science instruments or experiments.

Unit: A functional subdivision of a subsystem, or instrument, and generally a self-contained combination of items performing a function necessary for the subsystem's operation. Examples are electronic box, transmitter, gyro package, actuator, motor, battery. For the purposes of this document, "component" and "unit" are used interchangeably.

Limit Level: The maximum expected flight level (consistent with the minimum probability levels of Table 2.4-2).

Margin: The amount by which hardware capability exceeds requirements.

Module: See Level of Assembly.

Nonconformance: A condition of any hardware, software, material, or service in which one or more characteristics do not conform to requirements.

Offgassing: The emanation of volatile matter of any kind from materials into a manned pressurized volume.

Outgassing: The emanation of volatile materials under vacuum conditions resulting in a mass loss and/or material condensation on nearby surfaces.

Part: See Level of Assembly.

Payload: See Level of Assembly.

Performance Verification: Determination by test, analysis, or a combination of the two that the payload element can operate as intended in a particular mission; this includes being satisfied that the design of the payload or element has been qualified and that the particular item has been accepted as true to the design and ready for flight operations.

Protoflight Testing: See Hardware.

Prototype Testing: See Hardware.

Qualification: See Design Qualification Tests.

Redundancy (of design): The use of more than one independent means of accomplishing a given function.

Section: See Level of Assembly.

Spacecraft: See Level of Assembly.

Subassembly: See Level of Assembly.

Subsystem: See Level of Assembly.

Temperature Cycle: A transition from some initial temperature condition to temperature stabilization at one extreme and then to temperature stabilization at the opposite extreme and returning to the initial temperature condition.

Temperature Stabilization: The condition that exists when the rate of change of temperatures has decreased to the point where the test item may be expected to remain within the specified test tolerance for the necessary duration or where further change is considered acceptable.

Thermal Balance Test: A test conducted to verify the adequacy of the thermal model, the adequacy of the thermal design, and the capability of the thermal control system to maintain thermal conditions within established mission limits.

Thermal-Vacuum Test: A test conducted to demonstrate the capability of the test item to operate satisfactorily in vacuum at temperatures based on those expected for the mission. The test, including the gradient shifts induced by cycling between temperature extremes, can also uncover latent defects in design, parts, and workmanship.

Unit: See Level of Assembly.

Vibroacoustics: An environment induced by high-intensity acoustic noise associated with various segments of the flight profile; it manifests itself throughout the payload in the form of directly transmitted acoustic excitation and as structure-borne random vibration.

Workmanship Tests: Tests performed during the environmental verification program to verify adequate workmanship in the construction of a test item. It is often necessary to impose stressses beyond those predicted for the mission in order to uncover defects. Thus random vibration tests are conducted specifically to detect bad solder joints, loose or missing fasteners, improperly mounted parts, etc. Cycling between temperature extremes during thermal-vacuum testing and the presence of electromagnetic interference during EMC testing can also reveal the lack of proper construction and adequate workmanship.

1.9 ENVIRONMENTAL VERIFICATION COMMITTEE

It is recommended that the payload project establish an environmental verification committee. Its responsibilities should include assessment of environmental test requirements in accordance with current GSFC practices, approval of environmental verification plans and specifications, consideration of waivers, resolution of problems, and determination of corrective action. The committee should verify that the test program is adequate to enable the hardware to meet the mission objective, and it should evaluate test results to certify compliance with specifications. Members of the committee should include representatives of the following disciplines: payload management, instrument management, systems engineering, environmental testing, verification and flight assurance.

1.10 CRITERIA FOR UNSATISFACTORY PERFORMANCE

Deterioration or any change in performance of any test item that does or could in any manner prevent the item from meeting its functional, operational, or design requirements throughout its mission shall be reason to consider the test item as having failed. Other factors concerning failure are considered in the following paragraphs.

1.10.1 Failure Occurrence

When a failure (non-conformance or trend indicating that an out of spec condition will result) occurs, a determination shall be made as to the feasibility and value of continuing the test to its specified conclusion. If corrective action is taken, the test shall be repeated to the extent necessary to demonstrate that the test item's performance is satisfactory.

1.10.2 Failures with Retroactive Effects

If corrective action taken as a result of failure, e.g. redesign of a component, affects the validity of previously completed tests, prior tests shall be repeated to the extent necessary to demonstrate satisfactory performance.

1.10.3 Failure Reporting

Every failure shall be recorded and reported in accordance with the failure reporting provisions of the project.

1.10.4 Wear Out

If during a test sequence a test item is operated in excess of design life and wears out or becomes unsuitable for further testing from causes other than deficiencies, a spare may be substituted. If, however, the substitution affects the significance of test results, the test during which the item was replaced and any previously completed tests that are affected shall be repeated to the extent necessary to demonstrate satisfactory performance.

1.11 TEST SAFETY RESPONSIBILITIES

The following paragraphs define the responsibilities shared by the space project and facility management for planning and enforcing industrial safety measures taken during testing for the protection of personnel, the payload, and the test facility.

1.11.1 Operations Hazard Analysis, Responsibilities For

It shall be the joint responsibility of the test facility manager and the project manager to ensure that environmental tests and associated operations present no unacceptable hazard to the test item, facilities, or personnel. A test operations hazard analysis (OHA) shall be performed by the facility and project personnel to consider and evaluate all hazards presented by the interaction of the payload and the facility for each environmental test. All hazards discovered in the OHA shall be tracked to an agreed-upon resolution. The safety measures to be taken as a result of the OHA, as well as the safety measures between tests, shall be specified as requirements in the verification plan and verification specification.

1.11.2 Treatment of Hazards

As hazards are discovered, a considered attempt shall be made to eliminate them. This may be accomplished by redesign, controlling energy sources, revising the test, or by some other method. If the hazard cannot be eliminated, automatic safety controls shall be applied, for example: pressure relief devices, electrical circuit protection devices, or mechanical interlocks. If that is not possible or is too costly, warning devices shall be considered. If none of the foregoing methods are practicable, control procedures must be developed and applied. In practice, a combination of all four methods may be the best solution to the hazards posed by a complex system. Before any test begins, the project manager and test facility management shall agree on the hazard control method(s) that are to be used.

1.11.3 Facility Safety

The test facility manager shall verify that the test facility and normal operations present no unacceptable hazard to the test item, test and support equipment, or personnel. He shall ensure that facility personnel abide by all applicable regulations, observe all appropriate industrial safety measures, and follow all requirements for protective equipment. He shall ensure that all facility personnel are trained and qualified for their positions. Training should include the handling of emergencies by the simulation of emergency conditions. Analyses, tests, and inspections shall be performed to verify that the safety requirements are satisfied. The approach outlined in 1.11.2 shall be used to eliminate or control hazards.

1.11.4 Safety Responsibilities During Tests

The test facility manager shall appoint a safety officer to work closely with a safety officer designated by the space project. The facility designee shall ensure that the facility meets applicable Occupational Safety & Health Act (OSHA) and other requirements, that appropriate industrial safety measures are observed, and that protective equipment is provided for all personnel involved. The facility designee will ensure that facility personnel use the equipment provided and that the test operation does not present a hazard to the facility. The project designee shall ensure that project personnel use the equipment provided and that the test operation does not present a hazard to the space hardware, equipment, or personnel.

1.12 TESTING OF SPARE HARDWARE

A supply of selected spares is often maintained in case of the failure of flight hardware. As a minimum, spares must undergo a verification program equal to that required for follow-on hardware. Therefore, special consideration must be given to spares as follows:

a. Extent of Testing - The extent and type of testing shall be determined as part of the flight hardware test program. A spare unit may be used for qualification of the hardware by subjecting it to protoflight testing, and testing the flight hardware to acceptance levels.

b. Spares From Failed Elements - If a flight element is replaced for reasons of failure and is then repaired and redesignated as a spare, appropriate retesting shall be conducted.

c. Caution on the Use of Spares - When the need for a spare arises, immediate analysis and review of the failed hardware must be made. If failure occurs in a hardware item of which there are others of identical design, the fault may be generic and may affect all hardware of that design.

d. "One-Shot" Items - Some items may be degraded or expended during the integration and test period and replaced by spares. The spare that is used shall have met the required quality control standards or auxiliary tests for such items and shall be of qualified design. Examples are pyrotechnic devices, yo-yo despin weights, and elements that absorb impact energy by plastic yielding. When the replacement entails procedures that could jeopardize mission success, the replacement procedure should be successfully demonstrated with the hardware in the same configuration that it will be in when final replacement is to be accomplished.

1.13 TEST FACILITIES, CALIBRATION

The facilities and fixtures used in conducting tests shall be capable of producing and maintaining the test conditions prescribed with the test specimen installed and operating or not operating, as required. In any major test, facility performance should be verified prior to the test either by a review of its performance during a test that occurred a short time earlier or by conducting a test with a substitute test item. All equipment used for tests shall be in current calibration and so noted by tags and stickers.

1.14 TEST CONDITION TOLERANCES

In the absence of a rationale for other test condition tolerances, the following shall be used; the values include measurement uncertainties:

Acoustics	Overall Level:	≤ 1 dB	
	l/3 Octave Band Tolerance:	Frequency (Hz)	Tolerance (dB)
		f ≤ 40	+3, -6
		40< F < 3150	± 3
		f ≥ 3150	+3, -6
Antenna Pattern Determination		± 2 dB	
Electromagnetic Compatibility	Voltage Magnitude:	± 5% of the peak value	
	Current Magnitude:	± 5% of the peak value	
	RF Amplitudes:	± 2 dB	
	Frequency:	± 2%	
	Distance:	± 5% of specified distance or ± 5 cm, whichever is greater	
Humidity		± 5% RH	
Loads	Steady-State (Acceleration):	± 5%	
	Static:	± 5%	

Magnetic Properties			
	Mapping Distance Measurement:		± 1 cm
	Displacement of assembly center of gravity (cg) from rotation axis:		± 5 cm
	Vertical displacement of single probe centerline from cg of assembly:		± 5 cm
	Mapping turntable angular displacement:		± 3 degrees
	Magnetic Field Strength:		± 1 nT
	Repeatability of magnetic measurements (short term):		± 5% or ± 2 nT, whichever is greater
	Demagnetizing and Magnetizing Field Level:		± 5% of nominal
Mass Properties	Weight:		± 0.2%
	Center of Gravity:		± 0.15cm (± 0.06 in.)
	Moments of Inertia:		± 1.5%
Mechanical Shock	Response Spectrum:		+25%, -10%
	Time History:		± 10%
Pressure	Greater than 1.3×10^4 Pa (Greater than 100 mm Hg):		± 5%
	1.3×10^4 to 1.3×10^2 Pa (100 mm Hg to 1 mm Hg):		± 10%
	1.3×10^2 to 1.3×10^1 Pa (1 mm Hg to 1 micron):		± 25%
	Less than 1.3×10^1 Pa (less than 1 micron):		± 80%
Temperature			± 2°C
Vibration	Sinusoidal:	Amplitude	± 10%
		Frequency	± 2%
	Random:	RMS level	± 10%
		Accel. Spectral Density	± 3 dB